Physical Activity Levels in Children and Youth in the Province of Nova Scotia

Submitted to the Sport and Recreation Commission
Government of Nova Scotia

Revised December, 2002

Principal Investigator:

Phil Campagna Ph.D.
School of Health and Human Performance
6230 South Street
Dalhousie University
Halifax, NS

Co-investigators:

Gary Ness Ph.D.
Rene Murphy Ph.D.
School of Recreation Management and Kinesiology
Acadia University
Wolfville, NS

Roy Rasmussen Ph.D.
Angie Thompson Ph.D.
Department of Human Kinetics
St. Francis Xavier University
Antigonish, NS

Jack Porter, Ph.D.
Leisure Studies
University College of Cape Breton
Sydney, NS

Laurene Rehman, Ph.D.
School of Health and Human Performance
Dalhousie University
Halifax, N.S.

INTRODUCTION **3**

OBJECTIVES OF THE PROJECT **6**

METHODS **7**

Subjects 7

MEASUREMENT OF PHYSICAL ACTIVITY **8**

Instrumentation 8
Protocol 9
Questionnaire Administration 10
Data Reduction 11
Statistical Analysis 11

RESULTS **12**

Physical Activity 12
Body Composition 14

DISCUSSION **15**

Physical Activity 15
Body Composition 18
Major Recommendations for Future Study 19

REFERENCES: **20**

FUNDING AND SUPPORT FOR THE STUDY WAS PROVIDED BY THE: **24**

ACKNOWLEDGEMENTS **24**

APPENDIX A **25**

Sample size estimation *25*

Introduction

There is a growing national and international interest in disease prevention and the recognized link between physical activity and health. In North America it is recognized that physical inactivity is a major health problem (Blair et. al., 1989; Pate et. al., 1995). Research clearly shows that physical inactivity is an independent risk factor for coronary heart disease (CHD) (Berlin and Colditz, 1990). Moreover, as many as one third of the deaths in the United States from CHD, colon cancer, and type-2 diabetes can be attributed to sedentary living (Blair and Morrow Jr., 1998). Katzmarzyk et al. (2000) suggest that approximately 21,000 lives in Canada were lost prematurely in 1995 because of physical inactivity. Unfortunately, physical inactivity in the population remains a persistent problem despite the known health benefits of physical activity. Consequently, Canadian (Health Canada, 1999) and international organizations (World Health Organization [WHO], 1999) are working to address physical inactivity in populations around the world, and both the young and elderly are prime target groups for research.

Results from a recent pilot study in Nova Scotia (Campagna, et al., 2001) found that grade two students are active enough to meet the recommendations from the Forum on Physical Activity Among Children and Youth in Nova Scotia (Campagna and Maloney, 1999). This is in agreement with Tremblay and Haines (2000) recent report that all elementary school children (grade 1 and 2) achieved the moderate physical activity recommendation. In the same pilot study (Campagna, et al., 2001) however, only 1/3 of junior high and high school students achieved the physical activity recommendations, which are similar to the results reported by the National Population Health Survey (NPHS, 1999). This survey found that only 35% of youth are active enough to achieve optimal health benefits.

Research suggests that physically inactive children and youth are likely to become inactive adults (Kuhl and Cooper, 1992). Tremblay and Willms (2000) have shown that Body Mass Index (BMI) has increased during the past 20 years at the rate of nearly 0.1 kg/m^2 per year, for both sexes. The number of overweight boys and girls increased from

15% to 28.8% and 15% to 23.6% respectively from 1981 to 1996. These trends suggest that Canadian children aged 7–13 years are becoming progressively overweight and obese. This increase in body weight can be attributed in part to the increase use of computers for playing video games and searching the Internet, increased television viewing (Sallis et al., 1992; Trost, et al., 1996), and the decrease in physical education classes in schools (Sallis and Owen, 1999; Dale, et al., 2000). Inactivity during childhood could lead to an increased risk of life-style diseases in adulthood, such as heart disease and diabetes (Telama et al., 1997). As a result, physically inactive children have the potential to become extensive consumers of health care, contributing significantly to health care costs in the future (Riddoch and Boremam, 1995). Katzmarzyk, et al. (2000) have estimated that in Canada a reduction in health care expenditures of $150 million dollars a year can be realized from a 10% reduction in the prevalence of physical inactivity. Therefore, it has been suggested that prevention of chronic disease begins in childhood (Aarts et al., 1997; Berenson et al., 1995).

The determinants of physical activity have been described as multidimensional (Kohl & Hobbs 1998), encompassing psychological, social, physical environment, and demographic factors. It has also been proposed that some of the predictors of physical activity may be linked with each other (Welk 1999). Although the physical activity determinants have been well studied in adults these determinants in children and youth have not. To develop effective interventions for children and youth, the determinants and physical activity levels need to be well understood.

In 1997, the Federal/Provincial and Territorial ministers responsible for sport, recreation and fitness made a commitment with a goal to reduce the number of physically inactive Canadians by 10% by the year 2003. In Nova Scotia, this goal has been targeted to children and youth.

The Nova Scotia Sport and Recreation Commission formed an interdepartmental committee, Physically Active Children and Youth (P.A.C.Y.) to address children's inactivity in the province. P.A.C.Y. has representatives from Departments of Health,

Community Services, Education, and the N.S. Youth Secretariat. P.A.C.Y. is chaired by the Sport and Recreation Commission and has identified research as one of its priority areas.

In April 1999, the Sport and Recreation Commission and Dalhousie University collaborated to host a provincial forum to discuss physical activity among children and youth. Dr. James Sallis, a leader in the field of research on children and physical activity from San Diego State University, gave the keynote address, and was a resource at this forum. Delegates developed two key recommendations regarding physical activity and children and youth at this event.

1. That children and youth accumulate 60 minutes of moderate activity within each 24-hour period. Nevertheless, it must be recognized that every minute of physical activity makes some contribution to health.

2. That an objective measure be used to study children's physical activity level for a provincial study i.e. an accelerometer.

A population study of children's physical activity has never been conducted in Nova Scotia. In order to establish baseline data on the current physical activity levels of children and youth in this province, an initial research proposal was prepared during the summer of 1999.

In the fall of 1999, plans began for a study to measure the physical activity levels of children and youth in the province. This research is an important first step in establishing a benchmark from which objective measures can track changes in the physical activity levels of children and youth in the province of Nova Scotia.

Objectives of the Project

1. To identify the percentage of children and youth in Nova Scotia who meet the standard of 60 minutes of accumulated moderate physical activity in a 24-hour period on most days of the week using an objective measurement tool.

2. To determine the environmental, physiological and psychosocial determinants of physical activity in Nova Scotia children and youth.

3. To disseminate information (based on the research findings) to organizations that plan programs to promote physical activity.

4. To disseminate the research findings of the study to academics, professionals, volunteers and the general public, regarding the level of physical activity of children and youth in Nova Scotia.

Methods

Subjects

Data for this study was collected as part of a surveillance system on the physical activity levels of children and youth in Nova Scotia. Based on an estimate of the probability of detecting a model effect at a 5% significance level (see Appendix A), 6181 students were recruited from schools within the six Sport and Recreation Commission regions in Nova Scotia. The study included approximately 90 students (45 male, 45 females) randomly selected in each of the six regions from the following grades: 3, 7, and 11. This allowed for the maximum potential follow-up with the same subjects 3 to 4 years following the original data collection. Characteristics of the males and females used in the analysis are shown in Table 1.

Table 1. Demographic characteristics of grades 3, 7 and 11 males and females (mean ± SD).

Grade	Gender	Age (yrs.)	Weight (kg.)	Height (cm.)
Grade 3	Male (289)	8.1 ± 0.28	32.4 ± 8.20	132.8 ± 6.86
	Female (287)	8.0 ± 0.23	32.4 ± 8.19	131.4 ± 7.13*
Grade 7	Male (275)	12.1 ± 0.40	52.5 ± 14.55	156.8 ± 8.42
	Female (283)	12.0 ± 0.31*	52.6 ± 12.61	155.5 ± 10.45
Grade 11	Male (228)	16.2 ± 0.49	73.7 ± 17.29	175.6 ± 6.98
	Female (293)	16.2 ± 0.50	66.7 ± 24.04*	165.0 ± 6.43*

* Significant within grade gender difference ($p<0.05$)

Schools participating in the study were randomly selected in each Region. The school setting was used since it was the most convenient location to reach most children and

youth. Approval for the study was received from the Ethics Committees of Dalhousie University, Acadia University, St. Francis Xavier University and the University College of Cape Breton. Approval was obtained from all School Boards and schools selected in which the data was collected, if a school did not give permission, an additional school was randomly selected and permission requested. An informed consent was obtained from the primary guardian and each child. A contact person was selected for each school with all communication pertaining to the study channeled through this individual.

Measurement of Physical Activity

Instrumentation

The Computer Science and Applications Inc. (CSA) accelerometer (Actigraph model 7164) was used to obtain an objective measure of physical activity. The CSA unixal accelerometer is designed to detect vertical accelerations ranging in magnitude from 0.05 to 2.00 G's with a frequency response of 0.25 to 2.50 hertz. These parameters have been shown to allow for normal human motion with the rejection of high frequency vibrations from other sources. The acceleration signal is filtered and digitized with the magnitude summed over a user specific interval of time. At the end of each interval, the summed value or activity "count" is stored in memory and the numerical integrator is reset. The activity "counts" represents the summed magnitude and amount of the accelerations. For the present study, a one-minute sampling interval was used and data collected over 7 consecutive days. Previous research has shown that a 7-day data collection period provides reliable estimates of usual physical activity patterns of children and youth (Trost et al., 2000).

The CSA accelerometer has been shown to be a valid and reliable tool for assessing physical activity in children and youth (Janz, 1994; Trost et al., 1998). There are certain limitations with the accelerometer, which include the fact that they are not waterproof and therefore cannot be worn for activities such as swimming and may not provide precise measurement of some activities such as bicycling.

Protocol

A data collection team consisting of one male and one female was located at each of the four universities. Physical education teachers were seconded to provide one member of the team. The second member of the team was hired and when possible having a Certified Fitness Consultant (CFC) certification from the Canadian Society for Exercise Physiology (CSEP, 2001). The data collection took place during the fall months (September to December 2001) and winter (January to early March 2002). The duties of the data collection team in each of the four regions were as follows: All subjects were provided with a packet containing informed consent documents for the parents, consent form for the child, a letter explaining the study, a parental and child questionnaire. All questionnaires were assigned a code number to ensure confidentiality. Students giving consent were randomly selected to participate in the activity-monitoring portion of the study. No student randomly selected to participate in the activity-monitoring portion of the study was excluded from the study. Approximately 1340 students wore the accelerometer for 7 days between September and December 2001 and approximately 315 wore the accelerometer between January and early March (mostly Grade 11) (see Table 2).

Table 2. The number of questionnaires distributed/returned, consents and accelerometers worn and analyzed for grade 3, 7 and 11 students.

	# Distributed	# Returned	# Consent	# Wore Accelerometer	# Analyzed
Grade 3	2150	1243	1231	588	576
Grade 7	1997	1256	1013	590	558
Grade 11	2034	679	679	564	521

Note: # analyzed:
- Incomplete monitoring (n=51)
- Mechanical failures (n=24)
- Monitor loss (n=12)

Height, weight and body composition were measured prior to the placement of the activity monitor for each subject. Body weight and height were measured according to the Canadian Physical Activity, Fitness and Lifestyle Appraisal Manual (CSEP, 1998). Body composition was measured using a Tanita Body Composition Analyzer (Model

TBF-300A). The subject stood bare foot on two footpad electrodes located on the analyzer/scale. The analyzer/scale automatically measured body weight and impedance. Body impedance was measured when a small, safe electrical signal is passed through the body. Body composition was determined from the measured impedance, the subject's gender, height, and weight.

The activity monitor was placed on the right hip of each subject at the beginning of the school day. The unit was held firmly against the body in a Velcro pouch secured with a waist strap to insure consistency and proper positioning among the subjects. The placement at the hip permitted measurement of whole body movement and is the most frequently used site in epidemiological studies. The unit is small (5 x 4 x 1.5 cm), lightweight (43 grams) and did not interfere with activities of daily living and was worn over or under the subjects clothes as determined by each individual student..

Subjects were instructed to wear the activity monitor during all waking hours except when showering and to record any time that the monitor was not worn (e.g. swimming).

The day before monitor collection, the students' parents were contacted by telephone to remind them of the monitor retrieval the following day. The day of the monitor retrieval the data collection team contacted the person at each school to confirm that all monitors were returned. In the event that a monitor was not returned a follow-up telephone call to the parents or student (grade 11) that evening was made to ensure the monitor is returned the following day.

Questionnaire Administration

Questionnaires were administered to the following: parents, children, youth and physical education teachers. The purpose of the questionnaire was to collect information that may be related to the physical activity level of children and youth. The questionnaire was designed using existing evidence on a number of the factors that seem to correlate with physical activity levels of children (Allison et al, 1999; Janz et al., 2000; Reynolds et al., 1990: Sallis et al.,

1986; Saunders et al., 1997; Tappe et al., 1989; Trost et al. 1999). All questionnaires were assigned a code number to ensure confidentiality.

Data Reduction

After the seven days of data collection the stored activity counts were downloaded to an IBM compatible computer, stored on a compact disc, and transported to Dalhousie University for analysis. The CSA accelerometer data were reduced using custom software developed for the project. The software categorize each count per minute value into light (<3 METS), moderate (3-5.9 METS), hard (6-8.9 METS) or very hard (>9 METS) activity. A MET (metabolic equivalent) is an index of the intensity of activities. 1 MET is resting energy expenditure; therefore 4 METs would be equivalent to four times the intensity of resting state. The software calculated one minute counts and categorized them into one of the four intensities. Age specific count ranges corresponding to the above intensity (METS) levels were derived from an equation developed by Freedson et al. (2000).

$$METS = 2.757 + (0.0015 \times counts/min) - (0.08957 \times age\ [yrs]) - (0.000038 \times counts/min \times age\ [yrs])$$

Only physical activity data collected on five or more days were used in the final analysis.

Statistical Analysis

Percent calculations were used to determine the number of students that achieved the physical activity recommendations – accumulation of sixty minutes of moderate physical activity on most days of the week. The General Linear Model was used to compare gender within and between each grade and region in Nova Scotia. All statistical analysis was conducted using SPSS (Version 10.1). Statistical significance was set at $p<0.05$.

Results

Physical Activity

There were no significant differences in physical activity among the six Sport and Recreation Regions for any grades ($p>0.05$). Therefore, the physical activity data from all regions were combined for statistical analysis.

Means and standard deviations for daily physical activity levels are shown in Figure 1. For all grades males exhibited greater daily physical activity levels than females, however, only grade 7 males were significantly more active than grade 7 females. For both genders there was a significant difference in physical activity levels from previous grades ($p<0.05$).

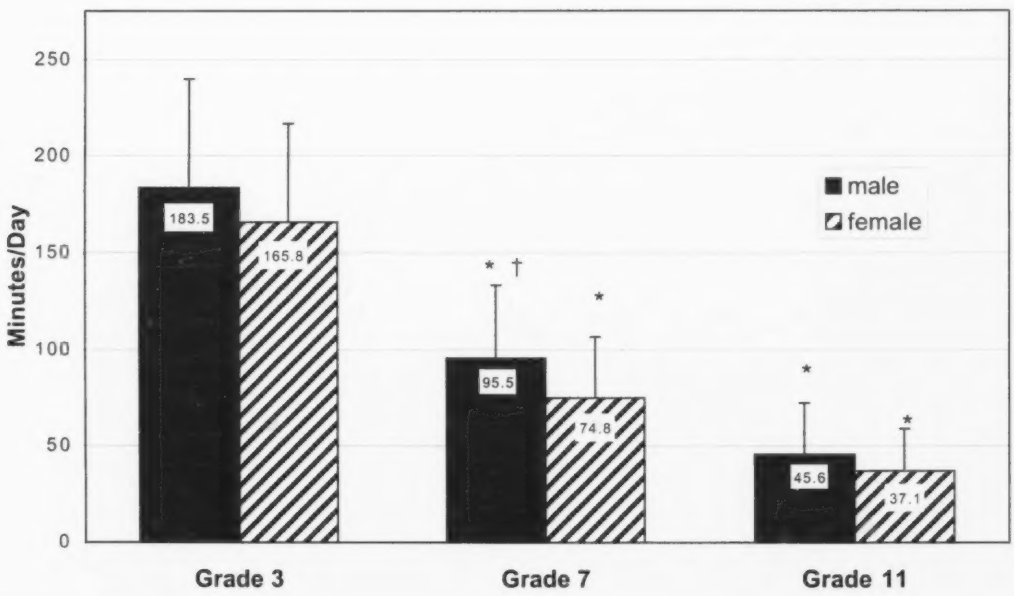

Figure 1 Means ± standard deviation for daily moderate or greater physical activity by gender and grade. * Significant gender difference between grades ($p<0.05$), † significant gender difference within grade ($p<0.05$).

Physical activity levels for grade 3 males and females ranged from 365.3 to 22.9 min/day and 308.9 to 29.9 min/day, respectively. Grade 7 physical activity levels for males and females ranged from 175.3 to 7.1 and 171.6 to 8.1 min/day, respectively. Grade 11 physical activity levels for males and females ranged from 127.1 to 4.3 and 117.6 to 2.6 min/day, respectively.

Ninety percent of grade 3 males and 92.3% of grade 3 females accumulated 60 minutes or more of physical activity on 5 or more days of the week (see Table 3). The percentage of grade 7 males that accumulated 60 minutes or more of physical activity on 5 more days of the week was significantly greater ($p.<0.05$) than the percentage of females (62% vs 44% respectively) (see Table 3). Only 12.6% and 6.9 % of grade 11 male and females respectively accumulated 60 minutes or more of physical activity on 5 more days of the week (see Table 3).

Table 3. Percentage of grade 3, 7 and 11 males and females that achieve <30, 30 to 60, and >60 minutes or more of moderate and vigorous physical activity on most † days of the week.

Grade	Gender	< 30 min. of MPA	30 to 60 min of MPA	>60 min of MPA
Grade 3	Male (289)	10.0%	0.0%	90.0%
	Female (287)	7.7%	0.0%	92.3%
Grade 7	Male (275)	36.7%	1.1%	62.2%*
	Female (283)	52.3%	3.2%	44.5%
Grade 11	Male (228)	82.6%	4.8%	12.6%
	Female (293)	88.6%	4.5%	6.9%

† 5 or more days per week.

* Significant gender difference ($p<0.05$)

The majority of grade 7 and 11 males and females, accumulated less than 30 minutes of physical activity on most days of the week (see Table 1).

Body Composition

The percentage of males and females classified as healthy weight, at risk for overweight and overweight are classified according to the Center for Disease Control criteria below:.

1. Healthy Weight <85th percentile for age & gender
2. At Risk for Overweight > 85th to <95th percentile for age & gender
3. Overweight >95th percentile for age & gender*.

* Children and youth above the 95th percentile have a significant likelihood of persistence of obesity into adulthood (Barlow and Dietz, 1998).

The estimated risk for overweight in grade 3 males and females was 17.6% and 24.7% respectively (see Table 4). The estimated percentage of overweight males and females in grade 3 was 19.4% and 19.9% respectively (see Table 4).

Table 4: Percentage of grade 3 males and females that are classified as healthy, at risk for overweight or overweight according to the Center for Disease Control criteria.

Gender	Healthy Weight	At risk for Overweight	Overweight
Male (n =289)	63.0%	17.6%	19.4%
Female (n=287)	55.4%	24.7%	19.9%

The estimated risk for overweight in grade 7 females was greater (20.5% vs. 16.4%) than for grade 7 males, however, the difference was not significant (see Table 5). The estimated percentage of overweight males and females in grade 3 was 20.4 and 19.4% respectively (see Table 5).

Table 5. Percentage of grade 7 males and females that are classified as healthy, at risk for overweight or overweight according to the Center for Disease Control criteria.

Gender	Healthy Weight	At Risk for Overweight	Overweight
Male (275)	63.3%	16.4%	20.4%
Female (283)	60.1%	20.5%	19.4%

The estimated risk for overweight in grade 11 males and females was 16.7% and 17.1% respectively (see Table 6). There was a significant difference in the estimated percentage of overweight males vs. females in grade 11 (16.2 and 7.9%) (see Table 6).

Table 6. Percentage of grade 11 males and females that are classified as healthy, at risk for overweight or overweight according to the Center for Disease Control criteria.

Gender	Healthy weight	At Risk for Overweight	Overweight
Male (228)	66.1%	16.7%	16.2%
Female (293)	75.0%	17.1%	7.9%*

* significant difference between males and females $p<0.05$

Discussion

Physical Activity

Elementary age students are significantly more active than junior high or high school students. For all grades, males were more physically active than females. Physical activity declined significantly from elementary school to junior high and high school. A recent study by Trost et al. (2002) found that this decline in physical activity occurs in elementary school rather than during adolescent years as report elsewhere (Kimm et al., 2000; Sallis et al., 2000; Telama and Yang,. 2000). Our results were unable to confirm this finding since only one grade was selected for elementary school.

The recommended amount of physical activity in Nova Scotia has been established (Campagna and Maloney, 1999) to be a minimum of 60 minutes of moderate intensity on most days (5 or more) of the week. Over 90% of both males and females in grade 3

achieved the above recommendation. Although the average amount of physical activity per day was higher than the recommendation for grades 7 males and females (95.5 and 74.8 mins/day, respectively), only 62% of the males and 44% of the females in grade 7achieved the recommendation. It is interesting to note that grade 7 male and female physical activity patterns are not consistent from day to day with a large variation in the amount of daily physical activity. Only 12.6% of the males and 6.9 % of the females in grade 11 were active enough to achieve the moderate physical activity recommendation. In a small number of cases, subjects participating in a sporting event were required to remove the accelerometer by the referee or coach. Therefore, the percentage of grade 11's achieving the recommended amount of physical activity could be slightly higher than reported.

The results indicate that high school students are significantly less active than the National Population Health Survey (self-report) results (NPHS, 1999). The NPHS survey found that 35% of youth are active enough to achieve optimal health benefits.

In elementary and high school students there was no gender difference in the percentage of males and females that achieved the moderate physical activity recommendation. However, there was a significant gender difference in the percentage of grade 7 males and females that achieved the recommendation.

To increase the percentage of grade 7 and 11 students that achieve the recommended amount of physical activity will require a well thought out strategy. It will require a substantial change in attitude and behaviour from children and youth,their parents, community, schools and government.

The amount of moderate to vigorous physical activity (MVPA) required to achieve the recommended levels in a substantial percentage of children/youth can be hypothetically calculated by adding 5 minute bouts (up to 30 mins/day) of moderate to vigorous physical activity (MVPA) to each of the subjects current daily levels (see Table 7 and 8)

Table 7 Percentage of grade 7 males and females that achieve the recommended physical activity criteria with increasing bouts of 5 minutes of MVPA.

	Male	Female
Current Physical Activity	62.2%	44.5%
⇑ 10 mins/day	73.1%	59.0%
⇑ 15 mins/day	78.5%	65.0%
⇑ 20 mins/day	82.2%	71.3%
⇑ 25 mins/day	84.4%	78.8%
⇑ 30 mins/day	87.6%	84.1%

Table 7 shows that over 87% of grade 7 males and 84.1% of grade 7 females could hypothetically achieve the Nova Scotia criteria with as little as 30 minutes of MVPA each day of the week.

Table 8 Percentage of grade 11 males and females that achieve the recommended physical activity criteria with increasing bouts of 5 minutes of MVPA.

	Male	Female
Current Physical Activity	12.6%	6.9%
⇑ 10 mins/day	18.2%	9.7%
⇑ 15 mins/day	19.0%	11.0%
⇑ 20 mins/day	24.7%	14.8%
⇑ 25 mins/day	29.9%	17.6%
⇑ 30 mins/day	36.4%	25.9%

Table 8 indicates that only 36.4% of grade 11 males and 25.9% of grade 11 females could hypothetically achieve the Nova Scotia criteria with as little as 30 minutes of MVPA each day of the week. This suggests that a considerable lifestyle change will be required for high school students.

Body Composition

Obesity in children and youth have been increasing at an alarming rate in many developed and developing countries including Canada(WHO, 1998; Tremblay et al. 2000). The results from the present study suggests that Nova Scotia children and youth are following these trends with 37% of males in both grade 3 and 7 and 32.9% in grade 11 considered to be at risk for overweight or overweight. Grade 3, 7 and 11 females at risk for overweight or overweight were found to be 44.6%, 39.9% and 25%, respectively. Grade 11 females levels of overweight were found to be significantly lower at 7.9%. The reasons for this lower level in grade 11 females are unclear at this time.

It is interesting to note that although over 90% of grade 3's achieved the recommended amount of physical activity (according to the Nova Scotia criteria) 37% were considered to be at risk for overweight or overweight. There are a number of possible explanations for the above results: (1) the standard of 60 minutes or more of moderate activity is not high enough to offset the increase prevalance of overweight, (2) moderate activity may not be beneficial enough in maintaining a health body weight, (3) the amount and/or quality of foods consumed are much greater than the activity expended. (4) the higher levels of body composition of children is a result of an imbalance in energy intake and expenditure from earlier grades and/or pre-school.

In summary, the use of accelerometers to determine physical activity in a population-based sample of children and youth is feasible and preferred to the traditional questionnaire based reports. In a cross-sectional study it is difficult to determine whether the physical activity patterns are consistent throughout the year. There is a possibility

that children/youth are more physically active during the summer months, further study is required to assess the possible seasonal variations in physical activity. Future studies should access energy intake amounts/levels to determine the relationship to the high overweight levels observed in the present study. As well, the current Nova Scotia criteria of 60 minutes or more of moderate physical activity on most days of the week should be examined to determine if this level is sufficient for health benefits in light of the high body composition levels of children and youth. A longitudinal study accessing physical activity levels of children and youth is critical to ensure that the low levels of activity seen (especially in grade 7 and 11) are reversed through a comprehensive strategy.

Major Recommendations for Future Study

The school boards, participating schools and teachers need to be contact as early as possible (May for September data collection) for permission to enter the schools.

Complete funding for the study should be secured before the commencement of the study.

A two day training workshop prior to the commencement of the study be organized to ensure that the data collection teams are completely familiar with the study objectives, data collection procedures etc.

Questionnaires and consent forms should be coded prior to the commencement of the study.

Six data collection teams be utilized (one for each Sport and Recreation Commission region) because of the extreme distances required to access the schools.

To obtain a greater return of the questionnaire and participation at the high school level it is recommended that the study become a component of the PAL class or the student councils become involved in helping to promote the study objectives.

References:

Aarts, H., Paulussen, T. & Schaalma, H. (1997). Physical exercise habit: on the conceptualization and formation of habitual health behaviours. **Health Education Research**, 12, 363-374.

Ainsworth, B.E., Haskell, W.L., Leon, A.S. et al. (1993). Compendium of physical activities: classification of energy costs of human physical activities. **Medicine and Science in Sports and Exercise**, 25, 71-80.

Allison, K.R., Dwyer, J.J.M., & Makin, S. (1999). Perceived barriers to physical activity among high school students. **Preventive Medicine**, 28, 608-615.

Barlow, S.E. and W.H. Dietz. (1998). Obesity evaluation and treatment: Expert committee recommendations. **Pediatrics**, 102(3): e29.

Berenson, G.S. & Pickoff, A.S. (1995). Preventative cardiology and its potential influence on early natural history of adult heart diseases: the Bogalusa Heart Study and the Heart Smart Program. **American Journal of Medical Science**, 310 (Suppl. 1) s133-s138.

Berlin, J.A. & Colditz, G.A. (1990). A meta-analysis of physical activity in the prevention of coronary heart disease. **American Journal of Epidemiology**, 132, 612-628.

Blair, S.N., Kohl, H.W., Paffenbarger, R.S., Clark, D.G., Cooper, K.H. & Gibbions, L.W. (1989). Physical fitness and all-cause mortality: A prospective study of healthy men and women. **Journal of the American Medical Association**, 262, 2395-2401.

Blair, S.N. & Morrow, Jr. J.R. (1998). Introduction: Cooper Institute/American College of Sports Medicine 1997 Physical Activity Intervention Conference. **American Journal of Preventative Medicine**, 15, 255-256.

Campagna, P.D., Kozey, J., Nordqvist, D. & Tetrault, C. (2001). Measuring physical activity levels of Nova Scotia children and youth: A research pilot, Sport and Recreation Commission, Nova Scotia Government.

Campagna, P.D. & Maloney T.L. (1999). Forum on physical activity among children and youth in Nova Scotia. Sport and Recreation Commission, Nova Scotia Government.

Canadian Society for Exercise Physiology (1998). **The Canadian Physical Activity, Fitness and Lifestyle Appraisal**, Ottawa, Ontario.

Canadian Society for Exercise Physiology (2001). Certified Fitness Consultant, www.csep.ca

Dale, D., Corbin, C.B. & Dale, K.S. (2000). Restricting opportunities to be active during school time: Do children compensate by increasing physical activity levels after school? **Research Quarterly for Exercise and Sport**, 71, 240-248.

Federal, Provincial and Territorial Advisory Committee on Fitness and Recreation. (1997). Physical inactivity: a framework for action. Ottawa: Health Canada.

Freedson, P.S., Sirard, J., Debold, N, Trost, S., Dowda, M., Pate, R. & Sallis, J. (2000). Calibration of a uniaxial accelerometer for estimating exercise intensity in children and youth. **Medicine and Science in Sports and Exercise**, (In Press).

Health Canada (1999). **Canada's Physical Activity Guide** Web site {on-line}. Available: www.pa.guide.com

Janz, K.F., Dawson, J.D., & Mahoney, L.T. (2000). Tracking physical fitness and physical activity from childhood to adolescence: The Muscatine study. **Medicine and Science in Sports and Exercise**, 32, 1250-1257.

Janz, K.F. (1994). Validation of the CSA accelerometer for assessing children's physical activity. **Medicine and Science in Sports and Exercise**, 26, 369-375.

Katzmarzyk, P.T., Gledhill, N. & Shephard, R.J. (2000). The economic burden of physical inactivity in Canada. **Canadian Medical Association Journal**, 163, 1435-1440.

Kimm, S.Y.S., Glynn, N.W., Kriska, A.M. et al. (2000). Longitudinal changes in physical activity in a biracial cohort during adolescence. **Medicine and Science in Sports and Exercise**, 32, 1445-1454.

Kohl, H.W. & Hobbs, K.E. (1998). Development of physical activity behaviors among children and adolescents. **Pediatrics**, 101, 549-554.

Kuhl, D.J.L. & Cooper, C. (1992). Physical activity at 36 years: Pattern and childhood predictors in a longitudinal study. **International Journal of Epidemiology**, 46, 114-119.

1996 - 1997 National Population Health Survey (1999). Ottawa, Ont., Statistics Canada.

Pate, R.R. Pratt, M., Blair, S.N. et al (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and the American College of Sports Medicine, **Journal of the American Medical Association**, 273, 402-407.

Reynolds, K.D., Killen, J.D., Bryson, S.W., Maron, D.J., Taylor, C.B., Maccoby, N., & Farquhar, J.W. (1990). Psychosocial predictors of physical activity in adolescence. **Preventive Medicine**, 19, 541-551.

Riddoch, C.J. & Boremam, C.A.G. (1995). The health related physical activity of children. **Sports Medicine**, 19, 86-102.

Sallis, J.F. (2000). Age-related decline in physical activity: a synthesis of human and animal studies. **Medicine and Science in Sports and Exercise**, 32, 1598-1600.

Sallis, J.F. & Owen, N. (1999). **Physical Activity and Behavioral Medicine**, Sage Publications Inc. Thousand Oaks, California.

Sallis, J.F., Simons-Morton, B.G., Stone, E.J. et al. (1992). Determinants of physical activity and interventions in youth. **Medicine and Science in Sports and Exercise**, 24 (suppl), S248-S257.

Sallis, J.F., Haskell, W.L., Fortmann, S.P., Vranizan, K.M., Taylor, C.B., & Solomon, D.S. (1986). Predictors of adoption and maintenance of physical activity in a community sample. **Preventive Medicine**, 15, 331-341.

Saunders, R.P., Pate, R.R., Felton, G., Dowda, M., Weinrich, M.C., Ward, D.S., Parsons, M.A., & Baranowski, T. (1997). Development of questionnaires to measure psychosocial influences on children's physical activity. **Preventive Medicine**, 26, 241-247.

Tappe, M.K., Duda, J.L., & Ehrnwald, P.M. (1989). Perceived barriers to exercise among adolescents. **Journal of School Health**, 59(4), 153-155.

Telma, R., Yang, X., Laasko, L., & Vikari, J. (1997). Physical activity in childhood and adolescence as predictor of physical activity in young adulthood**. American Journal of Preventative Medicine**, 13, 317-323.

Tremblay, M.S. & Willms, J.D. (2000). Secular trends in the body mass index of Canadian children. **Canadian Medical Association Journal**, 163, 1429-1433.

Trost, S.G., Pate, R.R., Sallis, J.F., Freedson, P.S., Taylor W.C., Dowda, M. & Sirard, J. (2002). Age and gender differences in objectively measured physical activity in youth. **Medicine and Science in Sports and Exercise**, 34, 350-355.

Trost, S.G., Pate, R.R., Freedson, P.S., Sallis, J.F. & Taylor W.C. (2000). Using objective physical activity measures with youth: How many days of monitoring are need? **Medicine and Science in Sports and Exercise**, 32, 426-431.

Trost S.G., Ward, D.S., Moorehead, S.M., Watson, P.D., Riner, W., & Burke, J. (1998). Validity of the computer science and application (CSA) activity monitor in children. **Medicine and Science in Sports and Exercise**, 30, 629-633.

Trost, S.G., Pate, R.R., Dowda, M. et al. (1996). Gender differences in physical activity and determinants of physical activity in rural fifth grade children. **Journal of School Health**, 66, 145-150.

Trost, S.J., Pate, R.R., Ward, D.S., Saunders, R., & Riner, W. (1999). Correlates of objectively measured physical activity in preadolescent youth. **American Journal of Preventive Medicine**, 17(2), 120-126.

Welk, G.J. (1999). The youth physical activity promotion model: a conceptual bridge between theory and practice. **Quest,** 51, 5-23.

World Health Organization (1998). Obesity: preventing and managing the global epidemic. Report of a WHO Consultation on Obesity, Geneva, June 3-5, 1997. World Health Organization: Geneva.

World Health Organization (1999). Active living [on-line]. Available: http://www.who.int/hpr/active/index.html

Funding and support for the study was provided by the:

Nova Scotia Department of Health
Nova Scotia Department of Education
Nova Scotia Sport and Recreation Commission
Health Canada - Fitness and Active Living Unit

In Kind support:
Acadia University
Dalhousie University
St. Francis Xavier University
University College of Cape Breton

Acknowledgements

Thank you to the students and staff of the schools for their co-operation in participating in the study.

Thank you to the following individuals for their participation in the study:

Annette Mahon
Lana Burns
Ellen McPhee
Mike Soares
Janet Cooper
Greg Grandy
Stuart Jamieson
Lindsay Clarke
Mike Arthur
Catherine Tetrault
Tony Martin
Ted Vaughan
Frank Covey
Ann Blackwood
Catherine Connors
Dan Nordqvist
Terri-Lynn Bennett
Nancy Smolders
Nancy Zanni

Appendix A

Sample size estimation

Prepared by Anthony Almudevar Ph.D., Department of Mathematics and Computing Science,
St. Mary's University

Table A-1. An estimate for the probability of detecting model significance for various combinations of sample size and effect size.

		Effect Size				
Total Sample Size	Number in grade/school combination	0.000	0.025	0.050	0.075	0.100
980	14	0.044	0.072	0.145	0.369	0.660
1260	18	0.054	0.078	0.177	0.452	0.815
1540	22	0.044	0.077	0.228	0.590	0.878
1820	26	0.035	0.077	0.283	0.682	0.953
2100	30	0.037	0.104	0.324	0.759	0.972
2380	34	0.033	0.082	0.401	0.832	0.991
2660	38	0.042	0.111	0.435	0.909	0.998
2940	42	0.040	0.112	0.504	0.928	0.999

The table gives an estimate of the probability of detecting a model effect at a 5% significance level. We assume that there are 7 regions. Within each region there are 3 schools and 5 grades. Within one school 4 grades are allocated and within the other two 3 grades are allocated according to an appropriate experimental design. Within each grade/school combination equal numbers of boys and girls are sampled. The response is assumed to be binary. To evaluate the power, we select an effect size, ranging over values 0, 0.025, 0.05, 0.075 and 0.10. It is assumed that one region differs from the others on average with respect to probability of positive outcome by the effect size. Boys differ from girls on average by the effect size. With in each region one school differs from the others on average by the effect size. The preceding table gives estimates for the probability of detecting model significance for various combinations of sample size and

effect size. Based on this and our definition of a clinically significant difference I would say that 1000 would be too few but 1500 - 2000 would be adequate.